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Supplement to the Environmental Assessment for Gila Trout Restoration in the Upper West Fork Gila River, Catron County, New Mexico: Considerations for addition of rotenone to the previous NEPA decision of 2003

By Jerry Monzingo and Amy Unthank

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Background

The Decision Notice (DN) and Finding of No Significant Impact (FONSI) resulting from the 2002 Environmental Assessment for restoration of Gila trout on the Wilderness Ranger District of the Gila National Forest was signed by the Regional Forester on January 13, 2003. The decision was to promote recovery by removal of the non-native trout with antimycin A in designated wilderness under the direction of a certified Forest Service pesticide applicator; salvage of a portion of resident native fish with electrofishing prior to chemical treatment and restocking after detoxification of the stream; treatment by experienced NMDGF, USFWS, and FS biologists to a concentration of 10 ppb Fintrol; detoxification with potassium permanganate at two stations; provision of public notice (including signing) of persons within 10 miles of the treatment area; complete electrofishing survey prior to reintroduction of Gila trout; a 3rd application if necessary beyond 2 initial applications of Fintrol; and reintroduction of the appropriate stock of Gila trout following confirmation of successful renovation.

Purpose and Need for the Supplement to the Environmental Assessment

The 2003 decision is based on the use of the piscicide Fintrol (the product tradename). Only two piscicides are currently registered with EPA and the states of Arizona and New Mexico. These two chemicals, antimycin A and rotenone, are available to fisheries managers in the United States for removal of non-native fishes (in addition to a lampricide for lampreys in the Great Lakes region). Antimycin A is only available in one formulation, Fintrol, produced and distributed by Aquabiotics corporation, a small family business. Rotenone comes in various formulations and is made by two major chemical companies. Both chemicals are in the process of re-registration with the EPA.

Bioassays for Apache trout renovations in 2007 revealed that the strength of the Fintrol product has been very variable and some batches have been severely compromised for reasons not explicitly known (exposure to extreme heat or other conditions of poor storage are suspected). Biologists with Arizona Game and Fish Department sent several samples of Fintrol to a USGS lab in LaCrosse, Wisconsin for analysis, with results indicating a large amount of variance of the strength of the active ingredient, with some Fintrol at 4.6% compared to the full strength (23% strength by volume). Fintrol batches have varied with 2006 Fintrol suspected as of extreme poor quality. Much of the Fintrol purchased for use in Apache and Gila trout renovation projects during the last three years is suspected to be poor quality, and biologists are trying to locate Fintrol made and purchased prior to 2005. At this time no new Fintrol has been forthcoming from Aquabiotics.

At the time of the Decision Notice and Finding of No Significant Impact (DN/FONSI) on January 13, 2003 and between 2004-2007 when Fintrol was applied to portions of the project treatment area during the summer field season biologists were expecting Fintrol to be fully effective at killing non-native trout. Rotenone had not been considered as an alternative to Fintrol because the New Mexico Department of Game and Fish requested the use of Fintrol for the project. A formulation of rotenone that is new to the United

States, but used for over a decade in Europe, is now registered in the U.S. This formulation (CFT Legumine™) was designed to reduce or eliminate petroleum hydrocarbon solvents, such as toluene, xylene, benzene and naphthalene, and through the reduction of those petroleum solvents, many of the negative properties such as chemical odor, water quality, applicator safety, public health concerns and detect ability by fish have been reduced. CFT Legumine™ was the formulation of rotenone chosen by California Department of Fish and Game and the U.S. Forest Service after analysis of ecological and human health risks in a joint Environmental Impact Report/Impact Statement for treatment of Lake Davis (Fisher 2007). This supplement provides new information on the status and use of the two existing piscicides and reviews the adequacy of the existing environmental assessment (EA) to determine if the use of CFT Legumine™ is consistent with the previous analysis.

Project Description and Significant Issues of the Gila Trout Restoration Environmental Assessment

In cooperation with NMDGF and USFWS the project decision allows for restoration of Gila trout to 21.3 miles of stream in the upper West Fork Gila watershed in designated wilderness. Specific actions include renovation to remove all brown trout and rainbow trout in 2-3 treatments/segment of stream over a 2-3 year period, followed by transport and stocking of Gila trout into the renovated waters. A natural barrier prevents upstream migration of non-natives back into the project area. The **significant issues** identified were: **recreation** (removing more waters from recreational fishing opportunities during renovation); **economics** (effects on local communities from reduced outfitter guide and visitor opportunities); **human health** (the possible impact through consumption of water treated with antimycin); and **aquatic and terrestrial species** (direct effects from antimycin on aquatic invertebrates, amphibians, existing native fish and indirect effects on terrestrial species that feed on dead fish).

Proposed Action with Supplemental Information

The Proposed Action is identical to the Environmental Assessment of 2002 and the DN/FONSI of 2003, except for the addition of rotenone, in the formulation of CFT Legumine™, as one choice for chemical renovation of the 21.3 miles of the streams in the upper West Fork Gila River drainage. Fintrol, should it become available again with the needed quality, will also remain available as an option for renovation to restore native fishes to the upper West Fork Gila River drainage.

Alternatives with New Information

No new issues were identified for this supplement. The alternatives considered in the 2003 decision notice (No Action and Proposed Action) have not been changed with the exception of the use of rotenone for eliminating non-native fish, especially brown trout which are now found throughout the upper West Fork Gila River drainage, with the exception of a few stream segments where they have not invaded. Mitigation and monitoring measure will remain identical. Section 7 consultation with the U.S. Fish and

Wildlife Service for the Chiricahua leopard frog and Gila trout has been initiated and the decision for this supplement will not be signed until consultation is completed.

Environmental Consequences

Piscicide Background: In a comparison of antimycin (Fintrol) and rotenone, rotenone has to be applied at a relatively higher dose (ppm vs. ppb), has longer degradation time when not detoxified by potassium permanganate, and can be detected by fish (and thus evaded without proper mixing). Rotenone is a naturally occurring substance derived from roots of certain tropical plants in the Leguminosae (bean) family, while antimycin is a chemical structure isolated from the bacteria *Streptomyces*. Both products interfere with mitochondrial electron transport and are potent inhibitors of aerobic respiration in fishes and other gill-bearing animals.

For this supplemental decision, a 5% formulation of CFT Legumine™ is proposed to be applied instead of the previous chemical Fintrol. The rate of application would be equal to or less than 1 part per million ($\leq$ 0.05 ppm pure rotenone) based on bioassays, and would be neutralized with potassium permanganate at the downstream terminus of the treatment area.

The application methods (EA at page 11), the mitigation and monitoring measures (EA at page 12), and the method of neutralization (EA at page 11) are the same for both antimycin and rotenone. As with antimycin (DN/FONSI at page 2), the application of rotenone would occur under the supervision of a certified pesticide coordinator and with biologists experienced in the application of both antimycin and rotenone.

Water Resources: There will be no change to water yield or hydrograph (EA at page 16). Some impacts to water quality will occur with CFT Legumine™, including longer degradation time of the chemical (on the order of a few days if not neutralized by potassium permanganate, as opposed to hours for non-neutralized antimycin applied to streams). As with antimycin detoxification at temperatures below 50F may require longer contact time between the treated water and the application of potassium permanganate (CFT Legumine™ label). Rotenone readily binds with organic matter and is unlikely to reach groundwater (Dawson 1991).

Rotenone, specifically CFT Legumine™, has a number of other ingredients including methyl pyrrolidone, diethylene glycol, monoethyl ether, fatty acid esters and polyethylene glycols, which help the product mix with water. A number of trace compounds have also been detected, including naphthalene, substituted benzenes and hexanol (Fisher 2007). None of the compounds identified are considered persistent in the environment nor will they bioaccumulate. They also rapidly biodegrade, hydroloyze and/or are broken down by sunlight. None of the constituents identified in extensive lab analysis (Fisher 2007) appear to be at concentrations that suggest human health risks through water or ingestion exposure scenarios, and none of the regulatory criteria were exceeded in estimated exposure concentrations in the study conducted for treatment of Lake Davis in California. In comparison to Noxfish™ (a different rotenone formulation

not proposed for application, but used by other states for fisheries management) substituted benezene concentrations were 0.091 ppb in CFT Legumine™ to 23.14 ppb (Fisher 2007).

The NMDGF previously petitioned the NM Water Quality Control Commission (Commission) for approval to utilize rotenone. During May 2008 a public hearing was conducted and the Commission approved the petition on August 11, 2008.

Wetlands, Riparian, and Aquatic Habitat and Biota: The 2002 Environmental Analysis indicated that no aquatic invertebrate data were available for the Upper West Fork Gila River project area (EA page 19). In accordance with the project specific Biological Opinion (USFWS 2002) the aquatic invertebrate community has been monitored before and after Fintrol treatment.

Preliminary observations have been compiled from the annual sampling at six locations on the West Fork Gila River and its tributaries (Jacobi 2006). A multi-metric assessment following approved Environmental Protection Agency (EPA) protocol was used to assess pre- and post-treatment aquatic macroinvertebrate communities. In comparison to pre-treatment community composition, the six sites varied from four sites rating as "non-impaired" (NI) after treatment to one site rating as "moderately impaired" (MI) and one site rating as "slightly impaired" (SI). Generally, these initial results indicate that the most downstream location(s) within the treatment area showed more decreases in community attributes (e.g. percent reduction in standing crop, percent reduction in total taxa, and percent reduction in sensitive indicator species) than the sampling sites located upstream.

As provided in Appendix A previous studies of the effects of antimycin and rotenone on aquatic macroinvertebrates indicates varied impacts, with some species being highly sensitive. The formulation of rotenone proposed for use in this project area (CFT Legumine™), a formulation chosen partly based on recent human health and ecological risk assessments done by California Department of Fish and Game (GDFG) and the U.S. Forest Service (USFS) in 2004 (CDFG and USFS 2005) for various formulations of rotenone (Fisher 2007), is expected to show similar varied effects in aquatic invertebrate communities, with the reduction of certain groups of macroinvertebrates, but no long term elimination of existing taxa. Based on rapid biodegradation and/or photolysis of the constituents in CFT Legumine™, no additional ecological impacts are expected beyond those previously described for antimycin (EA at page 21). As noted in the existing EA, aquatic invertebrate communities may be affected by the use of piscicides, but they also undergo natural variation in community composition due to other events such as fires and high run off. Past fires in the project area are also expected to have caused variability of aquatic invertebrates in the West Fork Gila River. Studies in other headwater stream systems have document lower diversity of macroinvertebrates in burned catchments for at least two years post-fire (Mellon et al. 2008).

As previously analyzed there will be no effects to wetland, riparian, or aquatic habitat, other than those analyzed under Water Quality (EA at page 21). Additional information is provided below in Appendix A specific to water quality and rotenone.

Terrestial Habitat and Wildlife: As previously analyzed there will be no change in the quantity or quality of terrestrial vegetation or wildlife habitat with the use of CFT Legumine™ (EA at page 23).

Management Indicator Species: The Management Indicator Species (MIS) list of the Gila National Forest was modified by amendment to the Land and Resource Management Plan (LRMP) in 2006. The list of MIS on the Forest was reduced from twenty five species or groups of species to ten species or groups of species. All species or groups of species on the current MIS list, with the exception of the Northern Goshawk, were on the original MIS list. Therefore the previous analysis (EA age page 26) would not change with the use of CFT Legumine™. The one species group, "Resident Trout", which included all native and non-native salmonids in the original MIS list, was changed to "Native Trout". Project activities were previously analyzed for potential effects to the northern goshawk in the Biological Assessment and Evaluation (Blue Earth Ecological Consultants 2002) and it was determined that the project would have no effects to the species.

Special Status Species: A review of the special status species (EA at page 29) and their analysis (EA pages 30-31) indicates that the sensitive species in the project area are the same, including those that would be evaluated under the updated Regional Forester's Sensitive Species list (USFS 2007). The 2002 Biological Assessment and Evaluation (BAE) was submitted to U.S. Fish and Wildlife Service and the service provided a Biological Opinion (B.O.) for the one species for which formal consultation was required, the Chiricahua leopard frog (USFWS 2002). The BAE and B.O. have been reviewed and the effects determination, mitigation measures, conservation measures, terms and conditions, and reasonable and prudent measures are still adequate to protect the species within the project area. However, due to increased concerns for the Chiricahua leopard frog consultation has been reinitiated by the U.S. Fish and Wildlife Service.

Heritage Resources: There will no change in the effects of heritage resources as analyzed (EA at page 33).

Socioeconomic Factors: The analysis is still applicable with the recognition that downlisting of Gila trout from Endangered to Threatened has occurred (USFWS 2006) since the EA was written and allowed for increased opportunities to fish for native trout, with possible economic benefits to local communities as stated in the EA (page 36).

Wilderness, Recreation, and Scenery: The issue was that renovation of the upper West Fork Gila River would result in more waters being removed from recreational fishing opportunities for locals and visitors (EA at page 27). With the downlisting of Gila trout from Endangered to Threatened it is highly likely that the upper West Fork Gila River

will allow for Gila trout fishing when renovation is completed and fish populations are determined to be adequate to allow for angling by NMDGF. The remaining analysis of wilderness and scenery values is not changed by the proposed use of CFT Legumine™.

Wild and Scenic Rivers: There is no change in effects to the eligible portion of the West Fork Gila River for designation as a Wild and Scenic River or the Outstandingly Remarkable Values (EA at page 40).

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APPENDIX A: Comparison of effects to non-target organisms and human health for Rotenone and Antimycin.

Aquatic macroinvertebrates

Rotenone- After laboratory based tests, Chandler & Marking (1982), concluded that: apart from an Ostracod (*Cypridopsis sp.*), aquatic invertebrates are much more tolerant of rotenone than most fishes and amphibian larval stages. In their study the most resistant organisms exposed were a snail (*Helisoma sp.*) and the Asiatic clam (*Corbicula manilensis*) for which the LC50 96h concentrations were 50 times greater than those Marking & Bills (1976) reported for the Black bullhead (*Ictalurus melas*), one of their most resistant fishes. Sanders & Cope (1968) also conducted lab tests examining the effect of rotenone to the nymph or naiad stage of a stonefly (*Pteronarcys californica*). They found that the LC50 24h was 2,900 µg/L and the LC50 96h was 380 µg/L. These values are greater by an order of magnitude to those found by Marking & Bills (1976) for the black bullhead (*Ictalurus melas*) indicating that aquatic invertebrates are much less sensitive to rotenone than fish. Larger, later instar naiads were less suceptible to given concentrations of toxin than were smaller, earlier instars of the same species (Sanders & Cope, 1968). Field studies examining the effect of rotenone on aquatic macroinvertebrate communities have provided varied results. Whereas some workers noticed dramatic, long-term effects (Mangum & Madrigal, 1999; Binns, 1967), others observed rotenone has a negligible effect on most aquatic macroinvertebrates (Demong, 2001; Melaas, 2001). Most researchers would agree, however, that the effects of rotenone are less pronounced and more variable to macroinvertebrates than the effects of the chemical on zooplankton. Like the range of sensitivities demonstrated by various fish species to rotenone, different species of aquatic macroinvertebrates also exhibit a range of tolerances (Mangum & Madrigal, 1999; Chandler & Marking, 1982; Engstrom-Heg et al., 1978) again perhaps based on their oxygen requirements.

Invertebrates in the orders Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and some members of Trichoptera (Caddisflies) are highly sensitive and have been completely eliminated by rotenone treatments in the past (Mangum & Madrigal, 1999). These sensitive species tend to be highly mobile and short life cycles, and may thus have the ability to repopulate depleted areas rapidly through dispersal and oviposition (Engstrom-Heg et al., 1978). Certain escape behaviors such as burrowing into benthos, associating with aquatic vegetation or the ability to trap air bubbles with appendages may reduce rotenone exposure to many benthic invertebrates. Of note, many studies have shown rapid population explosions of invertebrates following initial reductions in their biomass from rotenone treatment (Neves 1975, Cook and Moore 1969).

Antimycin- Reduction in abundance of certain groups of aquatic invertebrates is likely following antimycin treatments (Minckley and Mihalick, 1981). However, no invertebrate taxa are likely to be eliminated by antimycin treatments and abundance typically recovers with one to two years (Mangum1985, Mangum 1986, Jacobi 1988,

Brooks and Propst 2001). Toxicity tests using antimycin found that Cladocera, Copepoda, Amphipoda, Ephemeroptera, and Trichoptera may experience marked declines in abundance following antimycin treatments and that Amphipoda are particularly sensitive (Schnick, 1974). Antimycin typically does not adversely affect Protozoa, Rotatoria, Nematoda, Nematomorpha, Annelida, Ostacoda, Decapoda, Plecoptera, Odonata, Hemiptera, Coleoptera, Diptera, Gastropoda, and Pelecypoda (Schnick 1974).

Amphibians

Rotenone- Rotenone is toxic to amphibians, but generally less toxic than to fish. Rotenone may be absorbed into both skin and respiratory membranes, but skin may prevent more of a barrier due to a greater distance for the chemical to diffuse across (Fontenot et al., 1994), and a smaller surface area relative to gill structure. Indeed, Fontenot et al. (1994) reported that amphibian larvae with gills are most sensitive to rotenone. In standard laboratory 24-hour and 96-hour aquatic rotenone toxicity tests, the LC_{50} values for tadpoles and larval amphibians have ranged between 5 µg/L and 580 µg/L (24-hour tests and 25 µg/L to 500 µg/L in 96-hour tests (Fontenot et al. 1994, Chandler 1982). The adult Northern Leopard Frog demonstrated a much greater resistance with LC_{50} concentrations ranging from 240 µg/L and 1,580 µg/L (24 hours) and 240 µg/L and 920 µg/L (96 hours). This highlights the fact that tadpoles and other larval forms of amphibians that utilize gills for respiration are just as sensitive to rotenone as fishes while adult forms, no longer having to utilize gills, have a much lower susceptibility to rotenone. Larval amphibians appear to have resistance roughly equivalent to the most tolerant fish species. Rotenone is variably toxic to amphibians, depending on their mode of respiration (i.e. gills, skin, buccopharyngeal, or lungs). Differences in sensitivity occur among taxa and lifestages. Adults that are obligately aquatic or have high rates of cutaneous respiration are more sensitive as well.

Antimycin-Field studies of Fintrol application found no effect on frogs or tadpoles (genera not specified) at an application rate of 10 ppb (Berger 1965, Berger 1965b, Berger 1966a, Berger 1966a). Frogs and tadpoles in these studies were exposed for an indefinite amount of time (i.e. longer than 96 hours). The field tests wer conducted in ponds and Streams. Water temperatures ranged form 6°C to 21°C (43 to 70°F) and pH ranged from 7.9 to 8.8. Other field tests found no effect of 10 ppb antimycin over an indefinite period of time on Ranidae tadpoles (Gilderhus et al. 1969). Lab exposure studies found Fintrol-Concentrate to have no effect on leopard frog (R. pipiens) at concentration up to 48 ppb (Lesser 1972). However, bullfrog tadpoles were killed within 24 hours when exposed to antimycin at a concentration up to 40 ppb (Berger 1966c; Walker et al. 1964).

Mammals

Rotenone-Mammalian acute oral toxicity LD_{50} values for rotenone range from 39.5 mg/kg for female rats to 1,500 mg/kg for rabbits. For most lab mammals, rotenone is much more toxic when introduced intravenously or inhaled rather than taken orally. For example, the average oral LD_{50} for rats is 60 mg/kg compared with just 0.2 mg/kg for rotenone introduced directly into the bloodstream. Efficient breakdown of rotenone by the liver, oxidation of rotenone in the gut, and slow absorption in the stomach and intestines account for this significant difference in toxicity (Narongchai et al. 2005, Ling 2003). This explanation may also account for the significant difference in rotenone sensitivity between mammals and fishes, and not from a difference in the primary site of action between fishes and mammals (Fukami et al. 1969).

Antimycin- Extremely high levels of antimycin are required to produce toxic effects in carnivorous mammals similar to those that may occur in the project area. The oral LD_{50} for domestic dog is 5,000 mg antimycin/kg body weight. Thus, a domestic dog weighing 4.5 kg (10 lbs) would have to consume 57,900 kg (127,800 lbs) of antimycin-killed fish, using Ritter and Strong's (1966) maximum tissue concentration of 388 µg/kg. Field trials of 10 ppb antimycin treatments found no effects on raccoons.

Birds

Rotenone- Rotenone has a very low toxicity to wildfowl, and birds are extremely unlikely to be affected by 'normal' usage in fisheries management practices (Ling, 2003). Avian acute toxicity LD_{50} values range from 130mg/kg for the nestling English song sparrow (Cutcomp 1943) to 2200mg/kg for an adult mallard duck (USEPA 1988). In general, young birds are about 10 times more sensitive to rotenone poisoning (DFG 1994) and, like mammals, birds have a much-reduced tolerance to rotenone when it is introduced intravenously. Ling (2003) also examined rotenone poisoning and sublethal toxicity in birds as a result of consuming fish or even fish management baits. Ling concluded that "rotenone is slightly toxic to wildfowl, and birds are extremely unlikely to be affected by normal fisheries management programmes." For example, baits used to kill carp for management purposes have around 0.01 g of rotenone each. Ling calculated that a duck would need to consume approximately 200 baits to receive a fatal dose. It is very unlikely that birds would consume baits but they could consume fish killed by rotenone. The concentration of rotenone in poisoned fish is usually 25,000 times lower than that found in baits.

Antimycin- Vezina (1967) studied the toxicity of antimycin to mallard duck (Anas platyrhyncos) and found that ingestion of 2,900 mg/kg of antimycin was required to cause mortality of 50% of the test organisms. Using the highest residual concentration in dead trout of 338 µg/kg Reported by Ritter and Strong (1966), this translates to consumption of 7,474 kg (16,480 lbs) of dead trout. The amount of fish biomass that the treatment would generate (i.e. the total weight of all fish killed in the project area) would only be a fraction of this quantity. Field investigations found not effect on pelicans,

cormorants, herons, surface-feeding ducks or diving ducks, or osprey from consumption of fish killed by antimycin (Berger et al., 1967; Gilderhus et al.,1969). Berger and Lennon (1967) found no effect on osprey, gulls, or terns exposed to antimycin in dead fish and water after antimycin treatment.

Human Health

Rotenone- Millions of dollars have been spent on research to determine the safety of rotenone before approval of use from the U.S. Environmental Protection Agency. Much of this research has been directed toward potential effects on public health. This research has established that rotenone does not cause birth defects (Hazelton Raltech Laboratories 1982), reproductive dysfunction (Spencer and Sing 1982), gene mutations (Biotech Research 1981;Goethem et al. 1981; NAS 1983), or cancer (USEPA 1981, Tisdel 1985). When used according to label instructions for the control of fish, rotenone poses little, if any, hazard to public health. The USEPA has concluded that the use of rotenone for fish control does not present a risk of unreasonable adverse effects to humans and the environment.

Antimycin- Antimycin is an organic compound, discovered in 1945, that was isolated form Streptomyces griseus at the Department of Plant Pathology at the University of Wisconsin (Leben and Keitt 1948, Dunshee et al. 1949, Lehninger 1979). Degredation compounds of antimycin include blatmycic acid and antimycin lactone. These degredation compounds have very low toxicity for either fish or mammals (Herr et al. 1967). Direct ingestion of normal quantities of water containing 10 ppb anticycin during the peak of the treatment would have no effect on humans or livestock. Oral LD_{50} values for mammals range from 1.0 mg antimycin/kg body weight for lambs to 55 mg antimycin/kg body weight for mice (Herr et al.,1967). Oral LD_{50} is defined as the amount of antimycin that, when administered orally over a specified period of time, is expected to cause death of 50% of the group of test animals. For example, if a person weighing 70 kg (154.3 lbs) drank 1.5 liters (0.39 gallons) from a stream during treatment, he would ingest 15µg of antimycin, or 0.00021 mg antimycin/kg body weight. A 70 kg person would have to dring 12,600 liters (3,329 gallons) of treated water during the six-hour period that antimycin is active in the project area to ingest the amount required to achieve the LD50 for the most sensitive mammal tested (Guinea pig, LD_{50} = 1.8 mg antimycin/kg body weight). This translates to a water consumption rate of about 2,100 liters (555 gallons) per hour, which is physically impossible. Similarly, a 363 kg (800 lbs) horse would have to ingest about 65,300 liters (17,250 gallons) of treated water to reach the oral LD_{50} value of 1.8 mg antimycin/kg body weight for Guinea pigs. Numerous studies have been conducted on the effects of antimycin at the cellular level. None have reported any carcinogenic effects.